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ABSTRACT

The Zimbabwe Secondary School Science Project (ZIM-SCI) developed student study guides, corresponding teaching guides, and science kits for a low-cost science course which could be taught during the first 2 years of secondary school without the aid of qualified teachers and environmental laboratories. This ZIM-SCI study guide consists of activities and experiments in which students: (1) identify plant sex cells and sex organs; (2) study the mechanisms of pollination and fertilization; (3) investigate the development and dispersal of seeds and fruits; and (4) observe the life cycles in some plants and animals. Information is provided throughout the unit to help students understand the scientific principles behind the activities and experiments. Because the development of these principles has been carefully designed, it is essential that all experiments, activities, and discussions be done in the exact order in which they appear. (JN)

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ZIM–SCI

ZIMBABWE SECONDARY SCHOOL SCIENCE PROJECT

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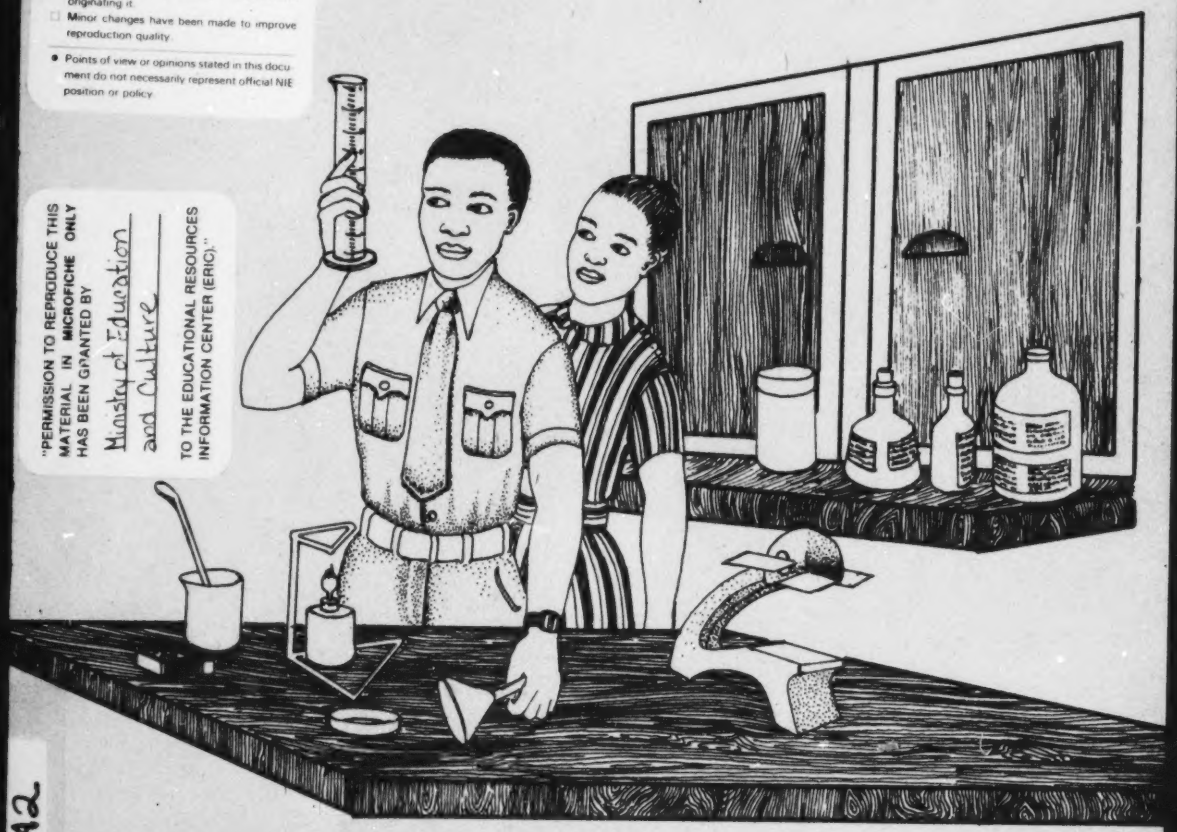

SE043842

STUDY GUIDE UNIT E2

Reproducing by Flowers and Seeds

UNIVERSITY OF ZIMBABWE
AND MINISTRY OF EDUCATION AND CULTURE

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October, 1981.

Zim - Sci

Zimbabwe Secondary School Science Project

GENERAL SCIENCE

STUDENTS : Please read this carefully. It will help you.

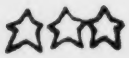
How you will study

This study guide comes to you with a kit of apparatus. Both things are part of a study programme leading you to an understanding of aspects of science. In this course you will be carrying out experiments. The study guide will help you to understand the scientific principles behind the experiments.

Your work should be done as you are instructed, either by the teacher or the study guide.

To help you to see quickly what you must do, the study guide uses these symbols.

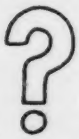
for "Read and revise your notes and Study Guide"



for "Take note of an important point that you should learn."

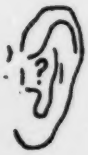
for "Summary". This is to help you to go over what you have learned.

for "Experiment".
When you see this sign, read the instructions carefully from beginning to end before you start to do the experiment.



for "How much do you know?"
This is for you, to help you to test whether you are remembering what is important.

for "Written work". This is when you must answer questions in writing.



for Listen to the teacher and do exactly what the teacher tells you to do

GENERAL SCIENCE

UNIT E2 : REPRODUCING BY FLOWERS AND SEED

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AIMS OF UNIT E2

When you have completed this study unit you will be able to:

1. Identify and draw plant male and female sex cells.

2. Identify, draw and label the male and female sex organs of a plant.

3. Define pollination.

4. Explain the differences between self-pollination and cross-pollination.

5. Describe the differences between insect-pollinated and wind-pollinated flowers.

6. Describe the advantages of cross-pollination.

7. Explain how plants prevent self-pollination.

8. Explain how fertilisation occurs in plants.

9. Describe what is inside a seed. Identify the main parts of a seed.

10. Define dispersal of fruits and seeds.

11. Explain the importance of dispersal.

12. Describe the different features which fruits and seeds have which help in their dispersal.

13. Draw a life-cycle of a named plant.

GENERAL SCIENCE UNIT E2

In Unit E1 you learned that animals produce special male and female sex cells called sperms and ova (eggs). Each of these cells has half the instructions needed to form a new organism. You also learned how a sperm and an ovum are brought together so that their nuclei can fuse (join) to form a fertilised cell. This cell then has a complete set of instructions and divides repeatedly, growing to be a new individual. You remember the process is called reproduction.

In this Unit you are now going to investigate how plants reproduce. You will start by looking at their special sex cells. These sex cells are made in special sex organs just as they are in the animals you studied in E1. But there is an important difference. In many plants the male and female sex organs are found together in the same part of the plant. This part of the plant is called the FLOWER.

EXPERIMENT 1 : Finding the male sex cells in a flower

You are going to need:

biomounts
bioviewers
scalpel
hand lens

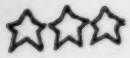
Your teacher will give you a flower to look at.

1. Observe your flower closely. Among the things you notice on parts of the flower is a yellow powder.

2. Shake some of this powder onto your clean biomount. Cover and observe under the bioviewer.

   Did you see separate pieces? Each piece is a plant male sex cell. It is called a POLLEN GRAIN.

3. Look at the biomounts of the pollen grains from different flowers, which other pupils have made. Perhaps you will see that pollen grains from different flowers are not the same. Your teacher will choose some Biomounts you have made, for you to look at under the microscope.



   Pollen grains are produced by male sex organs called STAMENS. Each stamen has got a head called the ANTHER which produces the pollen grains. It is usually yellowish in colour. See if you can find it. The anther is joined to the flower by a thin stem called the FILAMENT.

4. Draw two different pollen grains which you saw through the microscope.

5. Separate off one stamen carefully and draw it, labelling the anther and filament.

Keep your flower for the next experiment.

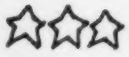
EXPERIMENT 2 : Looking at plant female sex cells

You will need:

a hand lens
biomount
bioviewer
razor blade or scalpel

1. The female sex organ of a plant is called a PISTIL. See if you can find it in the centre of the flower. Sometimes it looks like an anther but it does not have any pollen grains on it.

2. Carefully remove the stamens and outside parts of your flower so that you can see the pistil clearly. It will look something like this:



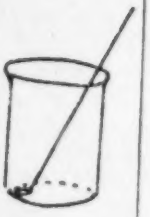
3. You will notice that the pistil has a little head at the top which is called a STIGMA. The thin stem of the pistil is called a STYLE. Like animals, a plant has an ovary. You will find the ovary as a swelling at the bottom of the style.

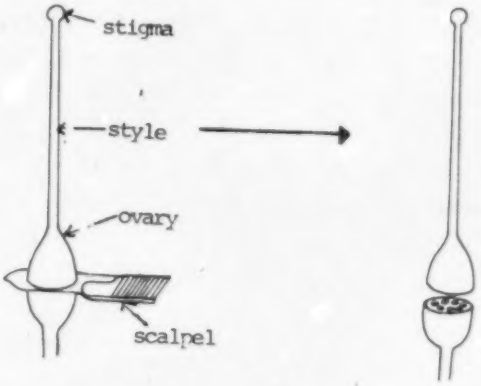
4. Draw and label the three parts of the pistil from your own flower

5. The ovary produces and protects the OVULES which are the plant's female sex cells. You will have to open an ovary to see the ovules which are inside.

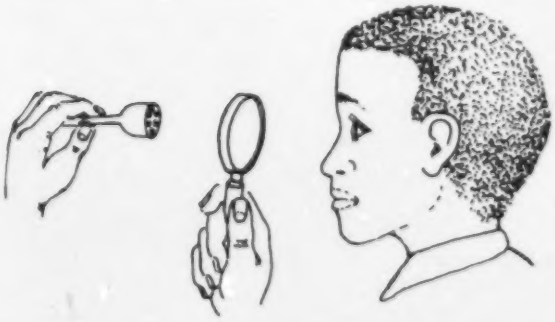
6. If your flower's ovary is big enough to hold and cut:
(about this size or larger)

Slice it across as in the diagram:





Look at the sliced surface using your handlens.
You should see the small eggs or ovules inside.

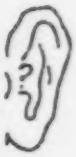


7. If, however, your flower's ovary is too small to hold and cut easily, put it in a micromount. Lay the micromount on your table and squash it by pressing with your finger. This should burst the ovary and squeeze out the ovules. Look at the biomount using your bioviewer.

   Draw an ovule and do Exercise 1.

The ovules could be seen easily with a handlens or bioviewer, but you had to use a microscope to see the pollen grains clearly. What does this tell you about their sizes?

In what ways are plant sex cells like animal sex cells? Discuss this with your teacher.



Now do Exercise 2.

PERTILISATION IN PLANTS

How do the pollen grains (male plant sex cells) reach the ovules?

You noticed that the pollen grains did not have tails like those of animal sperm. So they cannot swim! How then do the pollen grains reach the ovules? You are now going to find out how this happens.

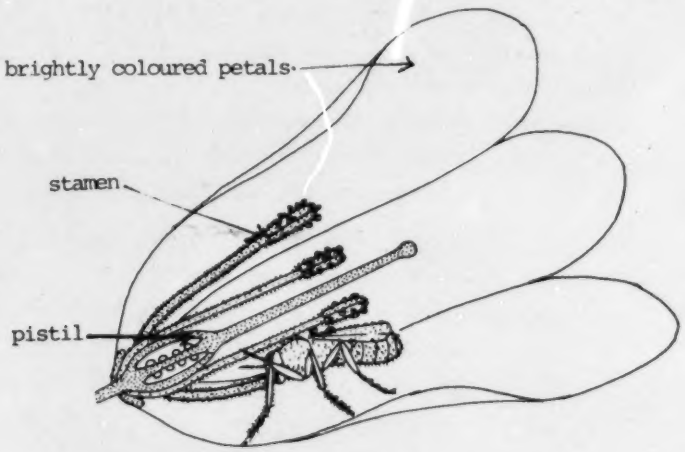
EXPERIMENT 3 : Looking at Insects near flowers

You will need:

the insect catching net (you made this for Unit A2)
handlens

Your teacher will take you outside to a place where lots of flowers are growing.

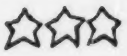
1. Sit down quietly near some flowers and observe carefully how insects behave near them.
2. Watch very carefully and try to find out what the insects are doing. Are they eating? If so, what are they eating?
3. Which parts of the flower do the insects rub against as they enter and as they leave the flowers?



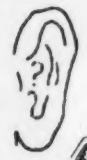
4. Try to catch one or two of the insects you see coming away from a flower by using your insect catching net.

5. Examine the insect with your handlens. See if you can find the hairs covering the body and legs. Is anything sticking to the hairs?

Discuss your observations with your teacher and then answer Exercise 3.



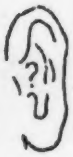
You have seen how insects help in getting pollen grains from the anthers to the stigma. This process is called POLLINATION. Do you think that the insects know that they are pollinating the flowers? Discuss this with your teacher.



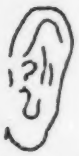
Now you can do Exercise 4.

You now know that flowers can either be self-pollinated or cross-pollinated.

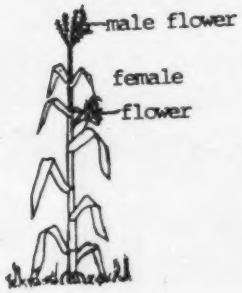
ADVANTAGES OF CROSS-POLLINATION



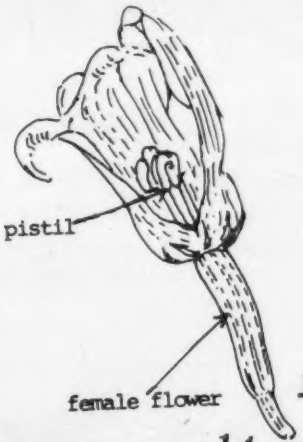
Cross-pollination has certain advantages over self-pollination. Can you think of some? Try to remember what you learned in Unit E1 about strength and variety. Discuss this with your teacher.
Plants have many ways of making sure that they get cross-pollinated. How? Three most common ways of making sure that cross-pollination takes place are:

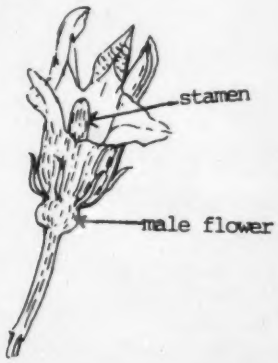


1. Instead of having the male and female organs in the same flower some plants put them in different flowers. Either they have female flowers with only pistils inside them or they have male flowers with only stamens inside them. Both the male and the female flowers grow on the same plant. Your teacher will show you a plant like a maize or pumpkin which does this.



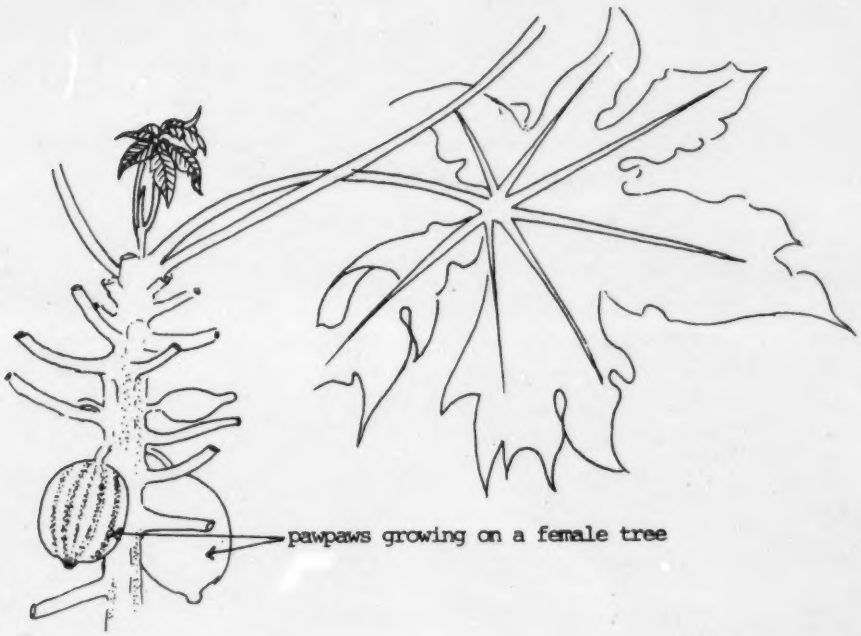
A maize plant





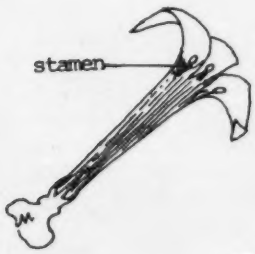
pumpkin flowers cut open

2. Some plants even have only male flowers on one plant and female flowers on another - paw paw trees do this.

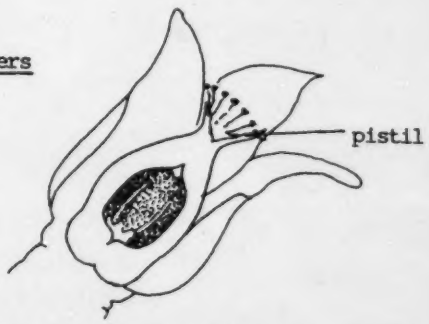


pawpaws growing on a female tree

pawpaw flowers



A male flower (cut in half) which is held out on a long stalk



A female flower (cut in half) which grows close to the trunk of the tree

3. In some plants the stamen makes pollen before the stigma in the same flower is ready to receive pollen. This means the flower cannot pollinate itself.

When you are at home try to look at some flowers on trees or vegetables and decide which kind of flower you are looking at. Check your examples with those of your class-mates and with the teacher.

Exercise 5: fill in the table which your teacher will put on the board.

ANOTHER WAY OF POLLINATING FLOWERS

Did you know that the tops of grasses and maize are flowers? They are not brightly coloured and pretty, they do not have a smell, but like other flowers they have sex cells in them. These flowers are very very small but may be found growing together on the plant. For instance, a maize plant has about 100 flowers the size of your finger nail on its top.

Insects do not visit these flowers because there is no bright colour or smell to attract them. Of course, these flowers will also not have any food for the insects! How do these dull coloured flowers become pollinated?

EXPERIMENT 4 : Looking at Dull Flowers

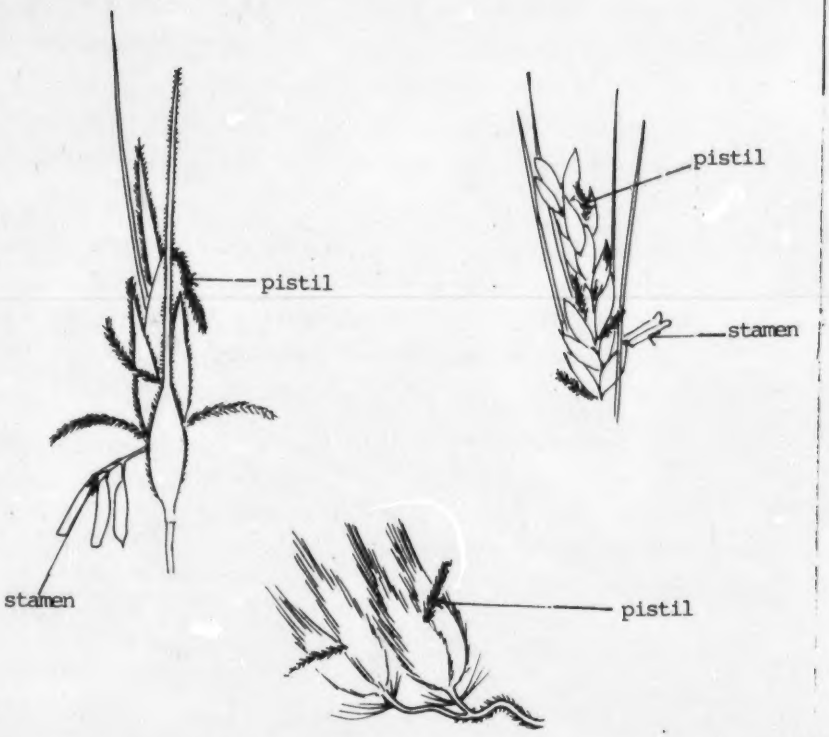
You will need:

- handlenses
- micromounts
- bioviewers

Your teacher will take you outside to pick the flower heads of grasses.

1. Observe carefully the position of the flower on the plant. Consider how you think it is pollinated.
2. Consider whether both male and female sex organs are in the same flower, or in different flowers.
3. Did you find many small flowers growing together on the plant?
4. Find the pistils and stamens. Can you count them? How big are they?

5. Compare your flower with the enlarged ones shown here.



SOME GRASS FLOWERS.

6. Using your handlens, look closely at the stigma.

7. Blow on the flower. Watch what happens to the pollen grains.

8. Put some pollen grains on the biomount and observe their size and shape under the bioviewer. How do they compare with pollen grains of bright flowers?

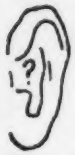
Discuss your findings with your teacher.
Now do Exercise 6.

WHAT HAPPENS TO THE POLLEN GRAINS AFTER POLLINATION

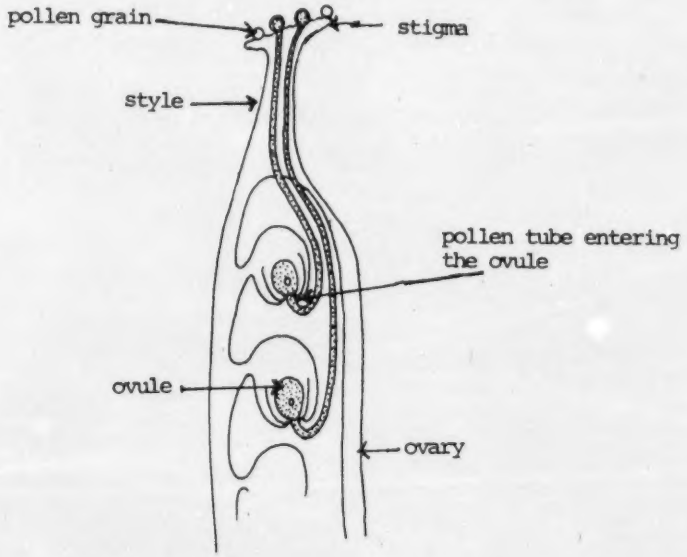
You have found out how the pollen grains get to the stigmas in different kinds of flowers. How do you suppose the pollen grains reach the ovules in the ovary?

You noticed that the pollen grains which contain the male sex cells do not have tails like animal sperm. So they cannot swim to the ovary.

The pollen grain sends a hollow tube down the style into the ovary. When the tube touches an ovule the male sex cell goes down the tube and fertilises it. The fertilised cell, which now has a complete set of instructions, can grow into a new plant.



Your teacher may be able to show you a pollen tube growing.



Here is an important question for you to discuss with your teacher. Can pollen from one kind of flower be used to fertilise the ovules in another? For example, will tomato pollen fertilise a pumpkin flower?

Now do Exercise 7.

Read and revise what you have learned in this Unit so far and then answer 'HOW MUCH DO YOU KNOW?'

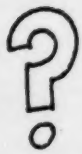
HOW MUCH DO YOU KNOW?

1. Stamens produce sex cells called ..... while the pistil produces sex cells called ..... .

2. Insects pollinate flowers which have ..... and ..... .

3. Sticky pollen grains are found in .....

4. Pollen grains of wind-pollinated flowers are ..... than insect-pollinated flowers.



5. An example of an insect-pollinated flower is ..... .

6. An example of a wind-pollinated flower is ..... .

7. Stamens and the pistil of insect pollinated flowers are usually ..... the flower while those of wind-pollinated flowers are always ..... the flower.

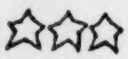
8. Varieties or hybrids are produced when there is ..... pollination and never in ..... pollination.

9. Pollen grains of one kind of flower will/will not grow into pollen tubes on a different type of flower.

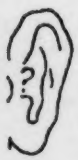
DEVELOPMENT OF THE SEED

In Unit E1 you learned how food and protection are provided for the different growing embryos. You should remember that in the chick and frog embryos food was provided in the eggs. In humans, rats and other mammals the young get their food through the placenta, and protection while being carried by the mother in its womb or uterus. Plants too provide care and protection for their embryos.

The fertilised cell divides repeatedly into many cells which will specialise into parts of a new plant embryo. While this dividing and growing is taking place a food store is being placed around the embryo by the plant.



The embryo and its food store is now called a SEED. It has a seed coat around it which protects it from damage and drying out. Unlike most animal embryos, which continue to grow after fertilisation, a plant embryo stops growing and will rest until it is ready to break out of its seed coat and grow into a new plant. This process is called GERMINATION. What do you think causes the seed to germinate? Discuss this important question with your teacher.



You are going to look at some bean seeds at different stages of development of the embryo.

EXPERIMENT 5 : Looking at Plant Seeds

You will need some:

drops of iodine from your teacher
your ruler
a handlens
a pin

Your teacher will give you:

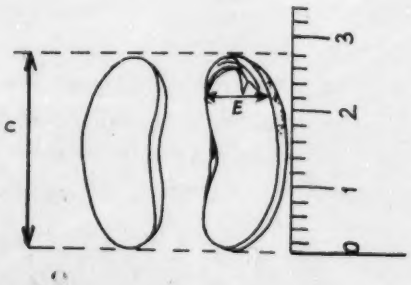
Four bean seeds.
One will be a dry one
One has been kept in water for 1 day
One has been kept in water for 7 days
One has been kept in water for 14 days

Look at the four seeds carefully, using the handlens, and observe the differences between them. This is called COMPARING. Copy the table your teacher has drawn on the blackboard before you start.

1. Compare your seeds with this picture of a seed.

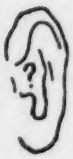
2. Compare the seed coats of the four seeds and fill in the table.

3. Compare the sizes of the four seeds by measuring them with your ruler. Can you explain the differences that you see? Fill in the table.



4. Hold each seed between the thumb and the first finger with the scar facing you. This scar shows where the seed was once attached to the ovary wall. Do you have such a scar?

5. Holding your lens above the scar, squeeze hard on each bean.



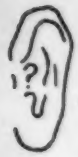
6. What comes out of the 'brown dot' below the scar? The 'brown dot' is a very small hole through which the male sex cell entered the ovule. When the seed is growing, water enters through this hole. Discuss your observations with your teacher.

LOOKING INSIDE THE SEED

1. Using your nails or a pin remove the seed coat from all the seeds.

2. Split the seed into two pieces along the crack. These two pieces are called COTYLEDONS. They are the food supply for the embryo.

3. If you look carefully you will see a tiny plant embryo still attached to one of the cotyledons. Can you see which part of the embryo will become the plant's root? Which part will become the plant's stem and leaves? (Shoot) Draw the open seed and label the embryo and the cotyledons, the future root and the future shoot.



Can you now explain:

1. What happens to the food in the cotyledons as the embryo starts to grow?
2. Why the embryo in the dry seed does not grow?

Discuss this with your teacher and then do Exercise 8.

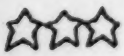
EXPERIMENT 6 : Changes in the Ovary after Fertilisation

You will need:

a scalpel or razor
a pencil
your notebook
your handlens

1. Go outside and look at the plants which had flowers before. What has happened to the ovaries in these old flowers?
2. Choose three developing ovaries of different sizes:
   (a) as seen in the flower;
   (b) half grown after flower has dried up;
   (c) the fully grown ovary containing ripe seeds.
   Draw a picture of each one. Your teacher will help you here.
3. Now cut open the ovaries. Observe the different sizes of the fertilised ovules and the changing thickness of the ovary walls. Draw each cut ovary.

Now do Exercise 9.



The ovary with the fully developed seeds inside is called a FRUIT.

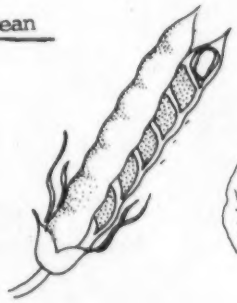
EXPERIMENT 7 : Looking at Fruits

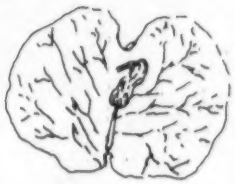
Collect as many different kinds of fruit as you can find. Remember a fruit is a ripened ovary on any plant, NOT just the kind you eat!

DIFFERENT FRUITS.

Gumtree

Bean



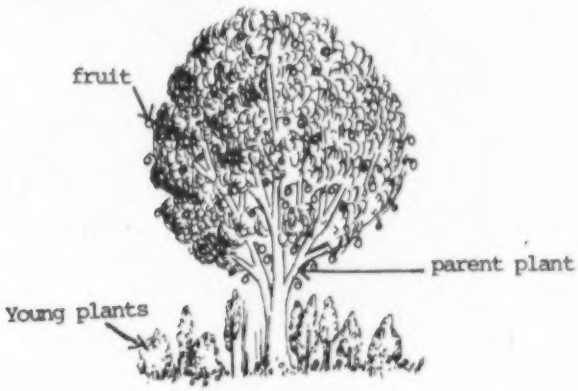


Bouganvillea

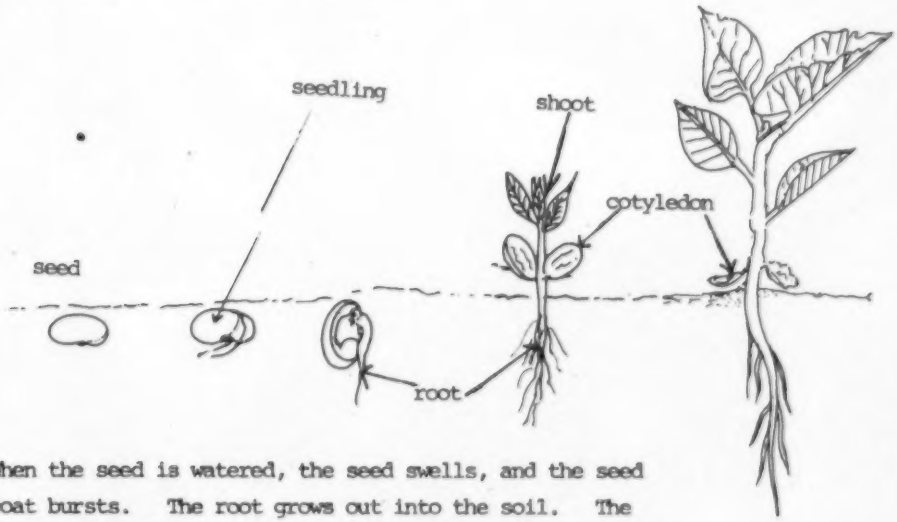
When you come back into the classroom:

1. Try to classify them, put them in groups, using some common characteristics, as you did with your field collection in Unit A2.
2. From your groupings make a key by discussing the characteristics of the fruits with your partner. Compare your key with those made by the rest of the class.
3. When you have finished, do not throw these fruits away. Keep them safely for the next lesson and for your collection.
4. Now complete Exercise 10 in your notebooks. Your teacher will put Exercise 10 on the blackboard.

Think about the fruits you picked. What would have happened if these fruits were left on the plant? Look at the picture below. Where did the young plants come from? Do you think that this is the best place for these young plants to grow? Discuss this with your teacher.



The young plant is called a SEEDLING.



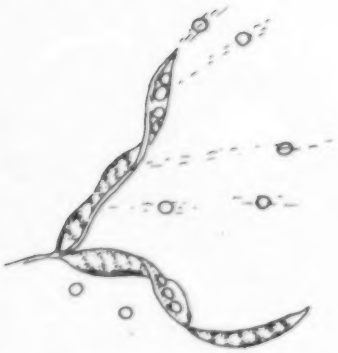
When the seed is watered, the seed swells, and the seed coat bursts. The root grows out into the soil. The shoot grows up into the air and light. The food store in the cotyledon is used for the growth of the plant. In the last diagram, the food store has been used up and the embryo has become a plant which can live on its own.

As you have learned, the young seedlings need space to grow. How does the parent plant find this space?

20

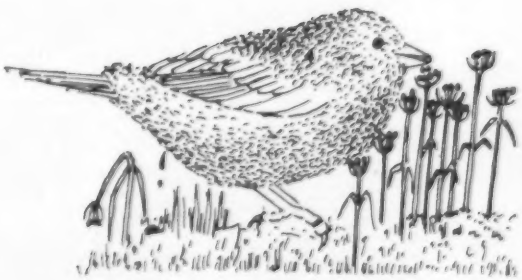
Look at the diagram, it is several puzzle pictures. The pictures show some of the plants and their seeds which you may know and perhaps have studied in preparing your key.

Write down in your notebook what you think is happening to the seeds in each picture.



Picture 1

Picture 2

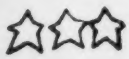


Picture 4

Picture 3

Now do Exercise 11.

You have seen that seeds and fruits are scattered in many ways from their parent plant. This scattering is called DISPERSAL and is very important to give the new plant the right conditions to grow.



EXPERIMENT 8 : Investigating the Dispersal of fruits and seeds in your collection

You will need:
your collection of fruits
your handlens

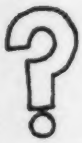
1. Look carefully at each of the seeds or fruits in your collection with your partner and try to decide how it is dispersed.

3. Fill in the table which your teacher will put on the blackboard.

4. Draw one example of each of the four ways in which dispersal happens.
Draw large diagrams and label them!

Go back and revise everything you have learned from the beginning of this Unit in preparation for another revision exercise.

HOW MUCH DO YOU KNOW?



1. A seed has an ..... and some food reserves.

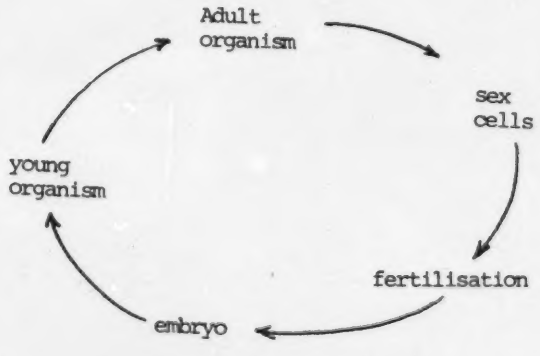
2. A seed is a ripened ..... while a fruit is a ripened ..... .

3. The scattering of seeds and fruits is called .....

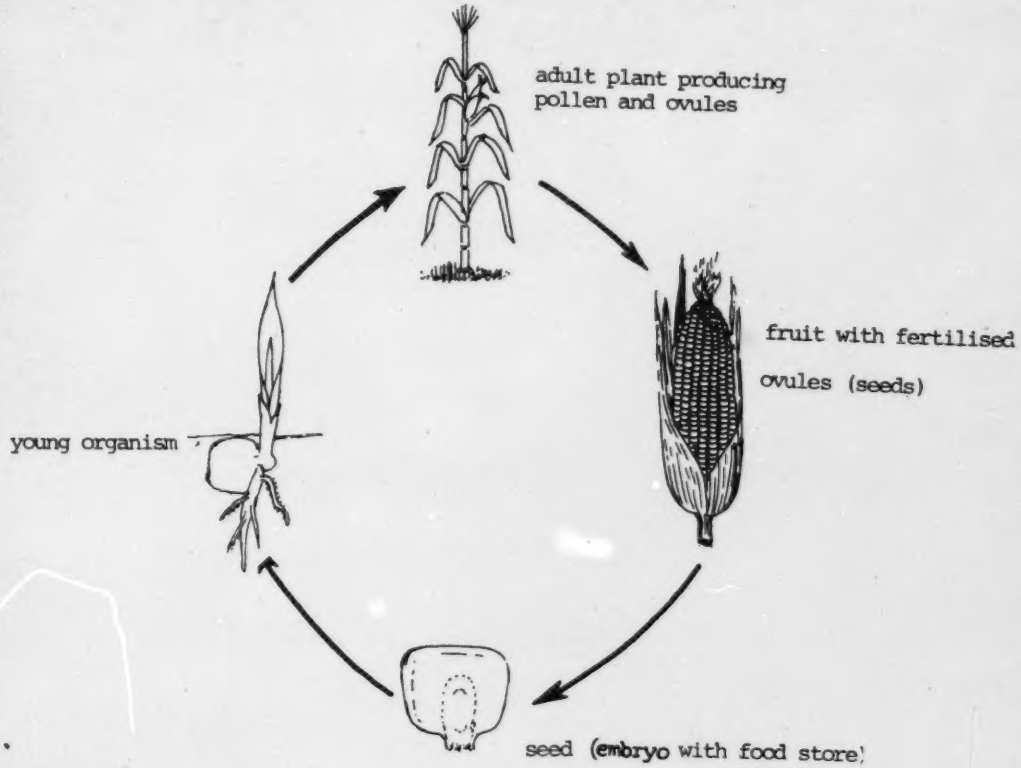
4. A seed germinates into a ..... .

WHAT YOU HAVE LEARNT ABOUT LIFE IN UNIT E

During the past few weeks you have been studying plants and animals. You have found out how animals reproduce (E1), how plants reproduce (E2) and how animals and plants develop (the observations you have been making on live organisms) It is possible to see there is a pattern in all living things. They are born, they grow and they reproduce more like themselves. This pattern is called a LIFE CYCLE.



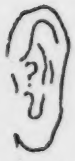
For a maize plant, a life cycle would look like this:


adult plant producing pollen and ovules
fruit with fertilised ovules (seeds)
young organism
seed (embryo with food store)

Now try to make life cycles in your book of two organisms you have observed. Choose one animal and one plant.

Look at all the life cycles and try to decide the point at which the organism is most likely to be weak and in need of care. If you are looking after young plants or animals, you will have to take special care at this point. However, if the organism is one which you do NOT want (such as a mosquito!) you will be able to see the point in its life at which you can most easily get rid of it.

You can see that a knowledge of life cycles is important in producing useful animals and plants and controlling unwanted animals and plants.



Your teacher will discuss some of these animals and plants with you now.

SUMMARY OF UNIT E

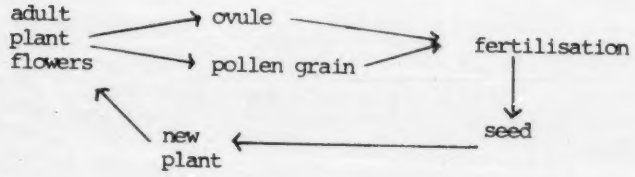
1. Plants have male and female reproductive organs in flowers.
2. The male reproductive organs are called stamens.
3. Each stamen has an anther which produces male sex cells.
4. The female reproductive organs are called pistils.
5. Each pistil has a stigma, a style and an ovary. The stigma catches the pollen grains. The ovary produces the female sex cells called ovules. The style joins the stigma and the ovary.
6. The process of transferring pollen from anthers to stigmas is called pollination.
7. If the pollination takes place within the same flower it is called self-pollination.
8. If the pollination takes place between flowers of the same kind it is called cross-pollination.
9. Pollination is helped by insects and wind. Some flowers are insect-pollinated and others are wind-pollinated.
10. The flowers and pollen grains for insect pollination are different from the flowers and pollen grains for wind pollination.
11. Cross-pollination is used by scientists to produce better varieties of plants
12. Fertilisation in plants occurs when the pollen nucleus fuses with the nucleus in the ovule.
13. A fertilised ovule develops into a seed.
14. A seed has a young embryo and a food store protected by the seed coat.
15. An ovary develops into a fruit.
16. Fruits and seeds need to be dispersed from their parent plant to prevent over-crowding.

17. Dispersal prevents over-crowding and competition for light, food and water.

18. Seeds and fruits are dispersed by wind, animals, water and by fruits bursting.

19. When the dispersed seeds get good conditions they grow into new plants and start the life cycle again.

20. A plant life cycle is like this:



21. An animal life cycle is like this: